Effect of Flipped Teaching Model on Computational Thinking Skills of Secondary School Students in the Subject of Computer Science

Muhammad Faisal Shahzad [1] **Jan Alam** [2] **Umbreen Ishfaq** [3] **Tehseen Tahir** [4*]

[1] M.Phil. Scholar, Department of Education, The University of Haripur, Haripur, Khyber Pakhtunkhwa, Pakistan.
Email: faisalshahzaddchs@gmail.com

[2] Associate Professor, Department of Education, University of Wah, Wah Cantt., Punjab, Pakistan.
Email: jan.alam@uow.edu.pk

[3] Professor, Department of Education, The University of Haripur, Haripur, Khyber Pakhtunkhwa, Pakistan.
Email: umbreenishfaq@uoh.edu.pk

[4] Assistant Professor, Department of Education, The University of Haripur, Haripur, Khyber Pakhtunkhwa, Pakistan.
Email: tehseen.tahir@uoh.edu.pk

ABSTRACT: The present study investigated the effect of the Flipped Teaching Model (FTM) on the computational thinking skills of secondary school students in Computer Science. An experimental research design was employed, and 60 male students were randomly selected from a population of 120 students at GHSS Kot Najibullah. The participants were divided into experimental and control groups based on their pre-test scores. A 100-item multiple-choice test was developed to assess computational thinking skills, and its validity and reliability were established before administration. The experimental group received instruction through the Flipped Teaching Model, while the control group was taught through the traditional method for eight weeks. Pre- and post-test data were analyzed using descriptive statistics, frequency distributions, and independent-samples t-tests through SPSS. The findings indicated that students taught through the Flipped Teaching Model performed significantly better than those taught through the traditional method, demonstrating its positive effect on computational thinking skills. The study recommends teacher training and adequate technological infrastructure to facilitate effective implementation of the Flipped Teaching Model at the secondary level.

KEYWORDS: Flipped Teaching Model, Computational Thinking Skills, Secondary School Students, Computer Science, Education

Pages: 368 – 380
Volume: 5
Issue: 4 (April 2026)

Corresponding Author
Tehseen Tahir
✉ tehseen.tahir@uoh.edu.pk

Cite this Article: Shahzad, M. F., Alam, J., Ishfaq, U., & Tahir, T. (2026). Effect of Flipped Teaching Model on Computational Thinking Skills of Secondary School Students in the Subject of Computer Science. *The Regional Tribune, 5*(4), 358-380. https://doi.org/10.55737/trt/v-iv.390

Introduction

Background

Flipped learning is a popular quality improvement strategy, yet there is still some controversy as to what it comprises. According to Mehring and Leis (2018), flipped learning "flips" the classroom. Sams and Bergmann (2013) and (Mehring & Leis, 2018). Flipped learning is an educational intervention that requires both the teacher and the students to have prior exposure to new content. These resources are then used in practice during face-to-face communication. But in the early 1980s, we dubbed it active learning to provide students with materials outside the classroom. Flipped learning theorists argue that students need support to cope with the new pedagogical situation (Evseeva & Solozhenko, 2015). In this review paper, we examine how recent meta-analyses have investigated the impact of technology on language learning.

Mehring and Leis (2018) built the flipped learning network, which confirmed the effectiveness of FL in helping teachers flip their classes more efficiently. Many countries have frequent conferences so that teachers can share their knowledge. Students study the textbook, then attend a face-to-face class, and engage in classroom activities. The class hour is utilised to teach, engage, and foster higher-order thinking skills (HOTS) through a range of activities to maximise learning. The FL strategy has been discovered to help students thrive in SL, and educators are seen to have a tendency to develop pupils holistically due to their instructional approaches (Sugano & Mamolo, 2021). The flipped classroom is a blended learning pedagogical approach that reverses the traditional teaching model by moving direct instruction outside of the classroom and using the classroom for active learning and application of themes (Chakawodza et al., 2024). This is generally done with students doing asynchronous work on the lecture subject (often videos or books) before class, with synchronous class time being used for collaborative work, problem solving and a closer look at issues (Mizza et al., 2025). This restructuring develops a student-centered culture that uses technology to deliver the foundational knowledge and to allocate class time for active-learning methodologies and individual instructor support (Aldaghri, 2024; Baig & Yadegaridehkordi, 2023). This shift allows teachers to transition from a didactic to a facilitator position, improving student engagement and strengthening higher-order cognitive skills through active learning experiences (Aldaghri, 2024; Khosravi et al., 2023). It's been used in education for a long time, but the advent of digital technology and online learning platforms has made it much more scalable and usable (Tunggyshbay et al., 2023). The idea of the flipped classroom was first introduced by Sams and Bergmann (2013) at the secondary school level, where learners can learn at their own pace and access online materials at any time (Chen et al., 2023; Huang et al., 2023). The paradigm also changes the old teacher-centered practices to more student-centered ones by increasing the connection between the teacher and the learner. This method encourages cooperative learning and gives extra time to study before, during, and after class, which can improve the learning process (Larsari & Abouabdelkader, 2024). Generally, the strategy is more effective than other methods of teaching in improving learning outcomes, especially at the secondary and higher education level (Naser et al., 2023). In this method, direct instruction (often in the form of lectures or grammar explanations) is transferred to pre-class study, and the classroom time is allocated for active learning activities such as discussions, group work, and exercises for knowledge application (Aldaghri, 2024; Aljermawi et al., 2023). This change in teaching allows students to focus on the subject before the live sessions and to come to the live sessions ready to interact and to build a better understanding (Wang, 2023). The reallocation of instructional time is meant to promote the development of critical thinking and problem-solving skills, shifting from passive information intake to a more dynamic and participatory learning process (Binoy, 2024). Such an approach is geared toward enhancing student participation and higher-order learning through cooperative and interactive learning opportunities (Aldaghri, 2024).

The teacher of computer science should think about using the flipped teaching approach to better understand what the pupils are learning. Teachers often say they are short-staffed and can't cover everything in the classroom. This is because they don't get enough time to make training interesting, and students are facing problems with programming languages and computational skills. They also waste their time in class and labs playing computer games. But they do not spend time on programming practice. Therefore, it is necessary to adopt FTM as a technique to improve teaching and learning. The teacher uses a variety of teaching strategies to cater to the needs of students of different levels and backgrounds. To teach computational abilities, teachers generally employ a lecture, presentation, project-based learning, or interactive teaching approach. A computational teacher could select among a range of teaching tactics to enhance student learning. Some of the teaching methods are very modern, while others have been used since ancient times. The flipped teaching technique is a new and current technique of training, which is being employed in many industrialized countries to develop computing skills.

Statement of the Problem

FTM is an active learning approach that is the outcome of a quest for a method that can suit the changing needs of the new period, and it has been welcomed enthusiastically by teachers and researchers (Turan & Akdag, 2020). A flipped classroom is where new material is presented to kids outside of class or school, usually using videos. Teachers guide students to engage in hands-on activities and practices in the classroom (Chuang et al., 2017). FTM is a new teaching method developed to teach and reinforce computational thinking skills.

Research Questions

1. Does the flipped teaching approach influence the computational thinking skills of secondary school computer science pupils?
2. What is the effect of FTM on secondary level students' development of computational thinking skills in the discipline of computer science?

Hypothesis of the Study

The null hypotheses of this study are:

H01: There is no significant difference in computational thinking capacity between the experimental group and control group before treatment.

H02: No significant difference in computational thinking ability between the control group and the experimental group after treatment.

H03: There is no significant effect of the Flipped Teaching Model on the computational thinking skills of secondary school children studying Computer Science.

H04: Traditional teaching techniques have no significant impact on the development of computational thinking skills among high school computer science students.

H05: There is no significant difference between the Flipped Teaching Model and Traditional Teaching Method approaches in terms of effectiveness in enhancing the computational thinking skills of secondary school students studying Computer Science.

Significance of the Study

This study is important for policymakers to establish legislation and initiate programs for the adoption of innovative teaching methods and flipped teaching approaches. "New technology is coming into the schools." Students are more engaged, and teachers are able to develop more interactive sessions. The results of this research can help professional trainers adopt the flipped method for various training programs. The study also provides a platform for future researchers to cross-examine the data on different themes, at different levels and in the regions of Pakistan. The study also provides an easy method for universities and professional training institutes to generate resources for the flipped classroom technique that can be used in actual classes.

Delimitations of the Study

This research was experimental, so it was delimited to one school, the GHSS Kot Najibullah, District Haripur. The school had 120 Students in grade $10^{th.}$ The study was limited to government schools alone and was selected because it best suited the desired population. Further, the study is limited to the teaching of computer science at the secondary level.

Research Design

Two comparable groups were formed for the experimental study: an experimental group and a control group, with an equal number of participants in each. The groups were constituted on the basis of students' pre-test scores to ensure comparable levels of prior knowledge and competency. A pre-test was administered to both groups before the intervention to establish their baseline performance. The experimental group was then taught using the Flipped Teaching Model, while the control group received instruction through the traditional teaching method. After the intervention, a post-test containing the same items as the pre-test was administered to both groups to determine changes in students' computational thinking skills.

Population

All the participants in both groups were studying at Secondary level in District Haripur. According to Annual Statistical report (2024 – 2025) prepared by EMIS of E&SED KP the District Haripur population consist of 32573 in 67 No of public (Boys) schools at secondary level. Out of which GHSS Kot Najibullah is selected for the purpose of study through random sampling technique.

Sample

For each group (experimental and control group), the thirty (30) students of computer science, grade 10th form the GHSS Kot Najibullah were selected based on pre-test scores. A total of sixty (60) students were selected for the purpose of the study and data collection.

Sample Technique

Random sampling technique was used to select the students from the given population of the school.

Variables of Study

The study consisted of one independent variable, namely the Flipped Teaching Model, and one dependent variable, namely the development of computational thinking skills among secondary school students.

Treatment

For the pre-test, test material was given to the participants. Students were instructed to respond in accordance with the guidelines stated. 100 MCQs from five (5) subcategories were included in the test, and two (2) hours of time were given to the participants for writing the test.

The researcher explained the test for better understanding. Students completed the test as a pre-test measure, which was accurately recorded for analysis. After conducting the test and marking, two random groups (control and experimental group) were created for the study.

The experimental group was selected based on the results of the pre-test. A total of 30 students were assigned to the experimental group (High achievers, mediocre and low achievers, 10 each). And the same for the control group; a total of 30 students were assigned to the control group (High achievers, mediocre and low achievers, 10 each). Both groups were treated separately; i.e., the flipped teaching model was used for the experimental group, and the lecture method was adopted for the control group. As a researcher, special training was conducted for Mr. Muhammad Atif, Secondary School Teacher (IT), for the lecture method for the control group, while the researcher adopted the flipped teaching method for the experimental group. A WhatsApp group was created for the experimental group for online communication and for sharing videos, notes, presentations and homework assignments. Special lesson plans, videos, presentations and notes were created for the experimental group. Two chapters (Unit No 1: Programming Techniques and Unit No 2: Programming in C) of the computer science text book grade 10th published by KP Textbook Board were taught to each group.

In the experiment, the researcher prepared several lesson plans, video lectures, notes, and presentations on selected units of a computer science textbook and also shared video lectures from YouTube channels such as https://sabaq.pk/:, https://www.youtube.com/c/khanacademy, and many other YouTube channels one day before the day of class; the researcher shared them with the students of the experimental group. Participants of the experimental group also received instructional and technical aids from the researcher. Students watched the videos or studied the notes at home and prepared their topic for the following day. The participants showed great interest in the class, and if they had any doubts or challenges, they would discuss them among themselves as well as with the teacher. Students talk to one another about what they have learned from Video, presentations and notes. In the classroom, they act as active learners and also participate in discussion sessions and answer questions during the flipped teaching approach. The experimental group also received instruction through face-to-face interactions, videos, presentations, notes, discussions, and other methods. After the experiment of 8 weeks, the pretest was administered again as the post-test for both groups to examine the change in their development of computational thinking skills.

Research Instrument

Students were assessed using two tools by the researcher.

1. An objective-type question paper of 100 MCQs was used for the pre-test and post-test as well as for both groups of participants. This question paper was used to analyze the performance of participants before the treatment, and also its score was used to split the students into two groups. The 100 MCQs were included in Unit No 1 and Unit No 2 of the KP textbook from computer science grade 10th.
2. Test items were designed from the selected chapters to assess the students' computational thinking skills in grade 10th.
3. At the end of a session of 8 weeks, a post-test containing the same items as the pre-test was used to measure the effect of the flipped teaching model approach on students' computational thinking skills.
4. A questionnaire of 40 items based on a five-point Likert scale was also used to measure the perception of the flipped classroom model from the experimental group.

Pilot Testing

Researcher tools were pilot tested on ten non-sampling students of secondary school level in Tehsil Ghazi, District Haripur. The pilot test sample was not included in the study groups. After 2 weeks of pilot testing, the pre-test was conducted, and data were collected for sampling.

Validity of Research Tool

A panel of specialists from the University of Haripur's Department of Education evaluated the questionnaire and question paper used in both. They made a few notes. These observations were re-examined, instruments were improved, and recommendations and opinions were taken into consideration.

Reliability

The degree to which a research instrument generates reliable and constant results is known as reliability (Creswell, 2014). Reliability of the tool was confirmed by pilot testing on 10 non-sampling students. The data were then examined in SPSS using "Cronbach's Alpha". Reliability co-efficiency on computational thinking skill exam was 0.821 and for questionnaire it was 0.81.These findings indicated that both tools were dependable enough to be used for data collection.

Data Collection

A pre-test was conducted by distributing a question paper. Both groups were taught separately, and a post-test was conducted. The sampled students filled the questionnaire in the presence of the researcher himself. The entire experiment took approximately 02 months (8 weeks) to complete; there was a nine (09) week interval between the pre-test and post-test.

Data Analysis

Statistical analysis of the data was done by Mean, Standard Deviation and t-Test. The mean was computed by utilizing the mean of the data. Standard deviation was used as an insight into the distribution of scores around the mean. Without standard deviation, we cannot compare the two data sets efficiently. So, the t-test was used to check the significant difference between high achievers and low achievers.

Table 1a

Comparison between Control Group and Experimental Group about Category I: Problem Solving and Algorithms after Intervention.

Paired Samples Statistics				
Group	**Mean**	**N**	**Std. Deviation**	**Std. Error Mean**
Control	21.1000	30	4.85195	.88584
Experimental	17.8000	30	3.43812	.62771

Table 1b

Paired Samples Test								
Group	**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**T**	**df**	**Sig (2-tailed)**
				Lower	**Upper**			
Control - Experimental	3.300	6.78817	1.23935	.76525	5.83475	2.663	29	.013

"A paired-samples t-test was conducted to analyze the post-test scores for Category I (Problem Solving and Algorithms) following the intervention. The analysis revealed a statistically significant difference between the experimental group and the control group, $t(29) = 2.66$, $p = .013$, 95% CI [0.77, 5.83]. The experimental group achieved a significantly higher mean score than the control group, with an average advantage of 3.30 points, demonstrating that the intervention successfully enhanced participants' problem-solving and algorithmic skills."

Table 2a

Comparison Between Control Group and Experimental Group about Category II: Decomposition/ Pattern Recognition and Abstraction after Intervention

Paired Samples Statistics				
Group	**Mean**	**N**	**Std. Deviation**	**Std. Error Mean**
Control	4.0667	30	1.52978	.27930
Experimental	2.2333	30	.72793	.13290

Table 2b

Paired Samples Test								
Group	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig (2-tailed)
				Lower	Upper			
Control - Experimental	1.8333	1.59921	.29197	1.23618	2.43049	6.279	29	.000

"A paired-samples t-test was conducted to analyze the post-test scores for Category II (Decomposition / Pattern Recognition and Abstraction) following the intervention. The analysis revealed a highly statistically significant difference between the groups, $t(29) = 6.28$, $p < .001$, 95% CI [1.24, 2.43]. The experimental group outperformed the control group by a mean difference of 1.83 points, demonstrating that the intervention was highly effective in improving participants' decomposition, pattern recognition, and abstraction skills."

Table 3

Comparison between Control Group and Experimental Group about Category III: Data Structure after Intervention

Paired Samples Statistics				
Group	Mean	N	Std. Deviation	Std. Error Mean
Control	5.9667	30	1.82857	.33385
Experimental	5.1000	30	1.84484	.33682

Table 3b

Paired Samples Test								
Group	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig (2-tailed)
				Lower	Upper			
Control - Experimental	.8667	2.23966	.40890	.03036	1.70297	2.119	29	.043

"A paired-samples t-test was conducted to evaluate the post-test scores for Category III (Data Structure) following the intervention. The analysis indicated a statistically significant difference between the experimental group and the control group, $t(29) = 2.12$, $p = .043$, 95% CI [0.03, 1.70]. The experimental group achieved a significantly higher mean score than the control group by an average of 0.87 points, demonstrating that the intervention had a positive effect on participants' understanding of data structures."

Table 4a

Comparison between Control Group and Experimental Group about Category IV: Programming Language and Troubleshooting after Intervention

Paired Samples Statistics				
Group	Mean	N	Std. Deviation	Std. Error Mean
Control	16.2333	30	4.16623	.76065
Experimental	12.1667	30	3.82445	.69825

Table 4b

Paired Samples Test								
Group	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig (2-tailed)
				Lower	Upper			
Control - Experimental	4.0667	5.41984	.98952	2.04286	6.09047	4.110	29	.000

"A paired-samples t-test was conducted to analyze the post-test scores for Category IV (Programming Language and Troubleshooting) following the intervention. The analysis revealed a highly statistically significant difference between the groups, $t(29) = 4.11$, $p < .001$, 95% CI [2.04, 6.09]. The experimental group significantly outperformed the control group, achieving an average mean difference advantage of 4.07 points. This indicates that the intervention was highly effective in strengthening participants' programming language proficiency and troubleshooting abilities."

Table 5a

Comparison between Control Group and Experimental Group about Category V: Programming Skills After Intervention

Paired Samples Statistics				
Group	**Mean**	**N**	**Std. Deviation**	**Std. Error Mean**
Control	8.0667	30	2.37709	.43400
Experimental	6.1000	30	2.42615	.44295

Table 5b

Paired Samples Test								
Group	**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**T**	**df**	**Sig (2-tailed)**
				Lower	**Upper**			
Control - Experimental	1.96667	3.12370	.57031	.80026	3.13307	3.448	29	.002

"A paired-samples t-test was conducted to evaluate the post-test scores for Category V (Programming Skills) following the intervention. The analysis demonstrated a strongly statistically significant difference between the groups, $t(29) = 3.45$, $p = .002$, 95% CI [0.80, 3.13]. The experimental group significantly outperformed the control group by a mean difference of 1.97 points, indicating that the intervention was highly effective in enhancing participants' overall programming skills."

Table 6a

Comparison between Pre-test Score vs Post-test Score Experimental Group about Computational Skill after Intervention

Paired Samples Statistics				
Group	**Mean**	**N**	**Std. Deviation**	**Std. Error Mean**
Control	36.7667	30	9.14135	1.66898
Experimental	55.4333	30	11.07866	2.02268

Table 6b

Paired Samples Test								
Group	**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**T**	**df**	**Sig (2-tailed)**
				Lower	**Upper**			
Control - Experimental	-1.86	10.19240	1.86087	-22.472	-14.860	-10.03	29	.000

"A paired-samples t-test was conducted to evaluate the overall growth in computational skills within the experimental group from pre-test to post-test. The analysis revealed a highly statistically significant improvement in scores following the intervention, $t(29) = -10.03$, $p < .001$, 95% CI [-22.47, -14.86]. On average, participants' overall computational skill scores increased by 18.67 points (*SD* = 10.19) from pre-test to post-test, demonstrating that the intervention had a profound and highly effective impact on overall learning outcomes."

Table 7

Comparison between Pre-test Score vs Post-test Score Control Group about Computational Skill after Intervention

Paired Samples Statistics				
Group	**Mean**	**N**	**Std. Deviation**	**Std. Error Mean**
Control	35.2000	30	7.03881	1.28510
Experimental	43.4000	30	7.71742	1.40900

Table 6b

Paired Samples Test								
Group	**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**T**	**df**	**Sig (2-tailed)**
				Lower	**Upper**			
Control - Experimental	-8.20	5.81556	1.06177	-10.371	-6.02844	-7.723	29	.000

"A paired-samples t-test was conducted to evaluate the overall growth in computational skills within the control group from pre-test to post-test. The analysis revealed a highly statistically significant improvement in scores over time, $t(29) = -7.72$, $p < .001$, 95% CI [-10.37, -6.03]. On average, control group participants' scores increased by 8.20 points (*SD* = 5.82) from pre-test to post-test, indicating that the traditional instruction method also yielded significant learning gains."

Discussion

The quantitative results of this study give strong evidence for the educational influence of the Flipped Teaching Model (FTM) on students' computational skills. Over time, the development of group study indicated a general difference between the two training methodologies. The CP group had a mean learning gain of 8.20 points, which was statistically significant (t(29)= -7.72, p < .001). The experimental FTM group had a substantial mean overall gain of 18.67 points (t(29)= -10.03, p < .001). Comparing the two groups, the total academic growth with the flipped technique was over double that of the increase with the traditional lecture style. At baseline, the groups were statistically equal on all pre-test categories; thus, we may have confidence in attributing this large difference in post-intervention growth to the flipped model. This is consistent with the recent meta-analytic study (Gong & Cai, 2023) that shows that, in general, the regular reversal of the instructional pipeline leads to improved student attainment in technology-intensive STEM disciplines compared to traditional direct instruction.

These huge learning improvements are primarily the result of the structural reallocation of in class time under the flipped paradigm. The most precious hours of face-to-face time in a standard computer science classroom are spent on passive information transfer - teaching grammar, presenting code- while students are left to struggle with sophisticated programs at home without support. But FTM shifts the basic conceptual exposure to autonomous pre-class scenarios and frees classroom time for collaborative, hands-on application. This active learning approach is well supported by present constructivist theories of learning, which argue that learners create a richer cognitive architecture by actively manipulating knowledge and solving contextual problems with their peers rather than passively listening to lectures. This is reinforced by a recent study by Chen et al. (2023) where they discovered that more real-time interactive feedback on class sessions produces significantly faster skill progress and conceptual retention in digital education circumstances.

The post-test results are discussed for each category separately to reveal the distinct cognitive implications of FTM on the several sub-domains of computational thinking. It was in Category IV (Programming Language and Troubleshooting) that the model performed best. It was the largest single gain in performance (4.07-point advantage in post-test mean difference ($t(29) = 4.11$, $p < .001$)). The key advantage is that the flipped format has given students the opportunity to explore grammatical limitations on their own and then utilize class time to collectively edit issue scripts in a manner similar to real-world engineering procedures. Furthermore, we discovered a very considerable statistical confidence ($t(29) = 6.28$, $p < .001$) that active learning spaces are particularly useful for the acquisition of abstract conceptions of a high level for Category II (Decomposition, Pattern Recognition and Abstraction). The focused findings confirm Gao and Hew (2022), who reported that the highest effect size of flipped classroom is in troubleshooting and systemic problem deconstruction.

The benefits are obvious, but the adoption of FTM has certain pedagogical limits and organizational obstacles to be explored by academics and teachers. The primary worries are that the children have to respect the rules and that they must be able to learn on their own outside the classroom. Obviously, our in-class active learning assignments are based on the materials we require you to read before class. So no kid coming to class unprepared can participate and stay up in class. FTM is not a “set and forget” approach. Learners are different in their preparation; therefore, pre-class compliance checks such as introductory quizzes or interactive video prompts need to be implemented to ensure responsibility.

Moreover, the technical dependence and needs of FTM are the systemic constraints of digital literacy. The flipped paradigm would mean all students would have equal and ongoing access to the digital infrastructure, functional technology and high-speed internet outside of school hours to attend digital courses. Socio-economic digital inequalities and unequal technical literacy may, unintentionally, widen achievement gaps in flipped classrooms and be detrimental to students from less privileged socio-economic backgrounds, as noted by Nadarajan et al. (2023). Plus, from the educational point of view, it requires a fantastic amount of work from the instructor from the start to create a solid flipped course. This requires instructors to design or acquire effective asynchronous materials and provide various active in-class interventions for diverse learner speeds that can burn out fast without institutional support.

Finally, the Flipped Teaching Model is shown as a very efficient paradigm shift for modern computing education, but practical limits exist. The current study demonstrates that this practice produced 2 times academic benefits compared to regular lecture approaches. The acquisition of sophisticated algorithmic skills is structurally inferior to active learning of students. Future work should seek to embed FTM into organized project-based workflows and institutional digital equity programs to optimize these educational benefits and to overcome the inherent limits of student under-preparedness and technical obstacles. The dynamic and constructivist framework of flipped classrooms can provide a sound basis for the development of 21st-century computing abilities for all children.

Conclusions

The study concluded that the Flipped Teaching Model (FTM) had a significant positive effect on students’ computational thinking skills at the secondary level. Before the intervention, no significant difference was found between the experimental and control groups, indicating that both groups had comparable levels of computational thinking skills. However, after the intervention, the experimental group showed significantly higher mean scores than the control group, particularly in problem-solving, algorithms, programming languages, and troubleshooting. The findings further indicated that students taught through FTM demonstrated greater interest, active participation, and engagement in learning compared with those taught through the traditional lecture method. The flipped classroom provided a supportive, interactive, task-oriented, cooperative, and innovative learning environment in which students had greater opportunities to interact with the teacher and access learning resources. Overall, the study established that FTM was more effective than the traditional teaching method in developing computational thinking skills among secondary school students.

Recommendations

The following recommendations are made in the light of the results discussed and the conclusion drawn.

1. According to the conclusion of this study, FTM has a significant effect on computational thinking skills. So, FTM should be preferred for the teaching of computer science at the secondary level rather than the traditional method of teaching.
2. The results of the study revealed that FTM is useful for computational thinking skill categories: Problem Solving and Algorithms, Programming Language and Troubleshooting. So teachers may be motivated to use the FTM method at every level, i.e. primary, middle, and high, for computer science education. In the modern era, innovative teaching strategies must be adopted. So the Department of Education may provide necessary resources for the teachers to utilize FTM for the students for better learning.
3. For active and effective participation of students, FTM is very effective; it enables the students to use their critical computational thinking and programming abilities. FTM would be adopted in order to increase students' interest in computational thinking skills and programming abilities.
4. Studies show that FTM is very useful and effective for teaching computer science and enhancing computational skills, but it would be used by teachers to teach Mathematics, General Science, English and other subjects, because this method is useful and effective for all subjects.
5. It is recommended that in Pakistan, Policymakers and stakeholders should take serious efforts to promote FTM strategies as a latest and modern teaching method in computational thinking skills at all levels of education. For this purpose, in-service and pre-service training must be provided to the teachers for better and effective learning.

References

Aldaghri, A. A. (2024). Incorporating flipped model in learning English grammar: Exploring EFL students' intrinsic motivation and attainment. *Journal of Language Teaching and Research, 15*(3), 863–872. https://doi.org/10.17507/jltr.1503.19

Aljermawi, H. N., Ayasrah, F. T., Al-Said, K., Abu-Alnadi, H. J., & Alhosani, Y. (2023). The effect of using flipped learning on student achievement and measuring their attitudes towards learning through it during the COVID-19 pandemic period. *International Journal of Data and Network Science*, *8*(1), 243. https://doi.org/10.5267/j.ijdns.2023.9.027

Baig, M. I., & Yadegaridehkordi, E. (2023). Flipped classroom in higher education: a systematic literature review and research challenges. *International Journal of Educational Technology in Higher Education*, *20*(1). https://doi.org/10.1186/s41239-023-00430-5

Binoy, S. (2024). Transforming Education: Enhancing Student Performance and Satisfaction through the Flipped Classroom Method. *American Journal of Education and Technology*, *3*(1), 35. https://doi.org/10.54536/ajet.v3i1.2121

Chakawodza, J. M., Mushayikwa, E., & Stephen, M. M. (2024). Exploring Challenges Influencing the Discontinued Utilisation of the Flipped Classroom Pedagogy: A Case of South Africa Underprivileged High School and Organic Chemistry. *International Journal of Learning Teaching and Educational Research*, *23*(10), 290. https://doi.org/10.26803/ijlter.23.10.14

Chen, X., Zou, D., Cheng, G., Xie, H., & Su, F. (2023). Effects of flipped language classrooms on learning outcomes in higher education: A Bayesian meta-analysis. *Australasian Journal of Educational Technology*, *39*(2), 65. https://doi.org/10.14742/ajet.8019

Chuang, H.-H., Weng, C.-Y., & Chen, C.-H. (2018). Which students benefit most from a flipped classroom approach to language learning? *British Journal of Educational Technology, 49*(1), 56–68. https://doi.org/10.1111/bjet.12530

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.

Evseeva, A., & Solozhenko, A. (2015). Use of flipped classroom technology in language learning. *Procedia - Social and Behavioral Sciences, 206*, 205–209. https://doi.org/10.1016/j.sbspro.2015.10.006

Gao, X., & Hew, K. F. (2022). Toward a 5E-based flipped classroom model for teaching computational thinking in elementary school: Effects on student computational thinking and problem-solving performance. *Journal of Educational Computing Research, 60*(2), 512–543. https://doi.org/10.1177/07356331211037757

Gong, D., Yang, H. H., & Cai, J. (2020). Exploring the key influencing factors on college students' computational thinking skills through flipped-classroom instruction. *International Journal of Educational Technology in Higher Education, 17*, 19. https://doi.org/10.1186/s41239-020-00196-0

Huang, P., Hwang, Y., & Huang, K.-S. (2023). The Investigation on College Students' English Writing Achievements and Perceptions towards a Flipped Instructional Model. *English Language Teaching*, *16*(5), 65. https://doi.org/10.5539/elt.v16n5p65

Khosravi, R., Dastgoshadeh, A., & Jalilzadeh, K. (2023). Writing metacognitive strategy-based instruction through flipped classroom: an investigation of writing performance, anxiety, and self-efficacy. *Smart Learning Environments*, *10*(1). https://doi.org/10.1186/s40561-023-00264-8

Larsari, V. N., & Abouabdelkader, H. (2024). An Investigation into Flipped Learning Classroom (FLC) of EFL Sixth Grade Students' Grammar Literacy Development: Implications for Student-Centered

Approach. *International Journal of Education and Literacy Studies*, *12*(1), 13. https://doi.org/10.7575/aiac.ijels.v.12n.1p.13

Mehring, J., & Leis, A. (Eds.). (2018). *Innovations in flipping the language classroom: Theories and practices*. Springer. https://doi.org/10.1007/978-981-10-6968-0

Mizza, D., Reese, M., & Malouche, D. (2025). Flipped classroom evaluation and blended learning potential: a case study of engagement and inclusion in quantitative education. *Smart Learning Environments*, *12*(1). https://doi.org/10.1186/s40561-025-00412-2

Nadarajan, K., Abdullah, A. H., Alhassora, N. S. A., Ibrahim, N. H., Surif, J., Ali, D. F., Mohd Zaid, N., & Hamzah, M. H. (2023). The effectiveness of a technology-based isometrical transformation flipped classroom learning strategy in improving students' higher order thinking skills. *IEEE Access, 11*, 4155–4172. https://doi.org/10.1109/ACCESS.2022.3230860

Naser, K., Alamassi, S., Shana, Z., Yousef, J., & Halili, S. H. (2023). Designing a Flipped STEM Classroom Engineering-Based Module: Fuzzy Delphi Approach. *International Journal of Interactive Mobile Technologies (iJIM)*, *17*(10), 4. https://doi.org/10.3991/ijim.v17i10.38217

Sams, A., & Bergmann, J. (2013). Flip your students' learning. *Educational Leadership, 70*(6), 16–20.

Sugano, S. G. C., & Mamolo, L. A. (2021). The effects of teaching methodologies on students' attitude and motivation: A meta-analysis. *International Journal of Instruction, 14*(3), 827–846. https://doi.org/10.29333/iji.2021.14348a

Tunggyshbay, M., Balta, N., & Admiraal, W. (2023). Flipped classroom strategies and innovative teaching approaches in physics education: A systematic review [Review of *Flipped classroom strategies and innovative teaching approaches in physics education: A systematic review*]. *Eurasia Journal of Mathematics Science and Technology Education*, *19*(6). Modestum Limited. https://doi.org/10.29333/ejmste/13258

Turan, Z., & Akdag-Cimen, B. (2020). Flipped classroom in English language teaching: A systematic review. *Computer Assisted Language Learning, 33*(5–6), 590–606. https://doi.org/10.1080/09588221.2019.1584117

Wang, L. (2023). The Impact of Student-Centered Learning on Academic Motivation and Achievement: A Comparative Research between Traditional Instruction and Student-Centered Approach. *Journal of Education Humanities and Social Sciences*, *22*, 346. https://doi.org/10.54097/ehss.v22i.12463